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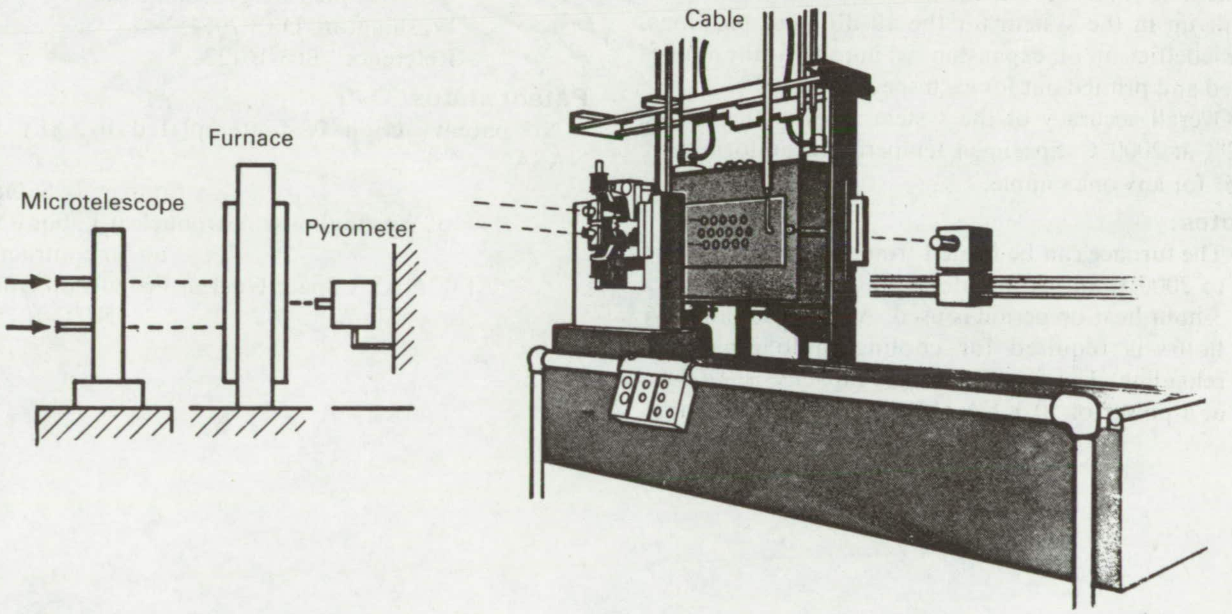
Measuring Thermal Expansion of Multiple Specimens at High Temperature



The problem:

To develop a technique that will determine the thermal expansion properties of a large number of specimens quickly and accurately.

The solution:

A furnace capable of heating 10 specimens to a uniform temperature simultaneously, and a technique that measures the expansion of each specimen with a single telescope.

How it's done:

The furnace uses two flat graphite hairpin heating elements, permitting a flat plate-shape heat zone and providing a furance construction geometry that allows easy loading and removal of specimens. The furnace is sealed and a vacuum is operated to reduce refraction errors caused by internal convection of inert gases.

The specimens are mounted upright on a pedestal between the two heating elements and placed to be visible through viewing ports in the front and back of the furnace. Attached to the top and bottom of each specimen are sharp-edged target flags that are easily distinguishable when viewed at temperature or with back lighting through the telescope unit.

The telescope unit consists of two microtelescopes mounted in a frame anchored in a large surface stone that is free to traverse (on an air-bearing surface) back and forth across another larger granite surface stone that provides the extremely stable platform necessary for accurate measurements. The air-bearing

(continued overleaf)

mounting provides flexibility in moving to the separate viewing ports and instant locking in place when the air is released.

The first measurement made on each specimen is the specimen length at room temperature, which is the difference in reading between the two telescopes when the cross hair in one is set on the top target flag and the other on the bottom target flag. After the specimens have been heated to temperature, both telescopes are adjusted on the target flags, and the difference between this reading and the previous reading is the extent of the expansion. Temperature values for calculating coefficient of expansion are obtained from a pyrometer mounted on a separate rack to the rear of the furnace.

The pyrometer output and both telescope potentiometers are hooked into a digital data acquisition system so that once a memory capability has been built up in the system for the 10 different positions, the coefficient of expansion is automatically calculated and printed out for each specimen.

Overall accuracy of the system is estimated to be $\pm 2\%$ at 2000°C. Specimen temperature uniformity is $\pm 5°$ for any one sample.

Notes:

1. The furnace can be heated from room temperature to 2000°C in 10 minutes, although in practice a 3-hour heat-up period is used. A period of about 4 hours is required for cooling, unloading, and reloading. The furnace design capacity is 2700°C, at a power of 50 KVA (1500 amperes maximum).
2. The microtelescopes are motor driven in all directions by remote control to prevent errors due to the operator resting his hand on the unit or moving it. The distance between the telescopes may be adjusted to any value within a range and this distance accurately determined by focusing the scopes on a calibrated glass scale. Each telescope is equipped with motor driven filar eyepieces and transmitting potentiometers. In addition, each scope is remotely focusable with small motors, and the two scopes after calibration and interlocking may be raised and lowered with a small motor.
3. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   AEC-NASA Space Nuclear
   Propulsion Office
   U.S. Atomic Energy Commission
   Washington, D.C. 20545
   Reference: B68-10122

Patent status:

No patent action is contemplated by AEC or NASA.

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